Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/429
JAPAN
February 1964
Submitted in:
ENGLISH and FRENCH

Confidential until official release during Conference

Abstract

DEVELOPMENT OF NUCLEAR FUEL INSPECTION TECHNIQUES IN JAPAN

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Inspection of nuclear fuels has a great significance from standpoints of securing the safety and economics of the fuels. Since the first reactor in Japan (JRR-1) came into operation in 1957, first inventory fuels for reactors have been imported, though fuels for several critical or sub-critical assemblies were produced in this country. It was JRR-3's second inventory fuels (natural uranium metal clad with aluminum) which were manufactured for the first time in domestic plants during 1963-64 and the Mitsubishi Group's research reactor fuels (enriched uranium oxide with aluminum sheath) followed.

In order to establish the inspection techniques for those home-made fuels, research and development works have been carried out among Japan Atomic Energy Research Institute (JAERI), Atomic Fuel Corporation (AFC) and private industries. Non-destructive testing techniques thus developed so far include: (1) application of ultrasonics for detecting internal defects in uranium billets, (2) radiographic measurement of aluminum cladding thickness, ultrasonic bonding test and determination of α contamination degree by ionization chamber device, which were developed especially for uranium metal fuels of JRR-3 and (3) eddy current test for sheath tubing of Mitsubishi Group's Reactor fuels. They are discussed in this report with emphasis upon the newly-developed or modified NDT techniques studied in Japan. Works have also been going on for other inspection techniques related to the other types of fuels that are considered to be used in this country, which will be briefly surveyed too.

There has been a committee in AFC comprised of specialists from fuel manufacturers, users and academic circles, which was established for the development of inspection techniques for home-made fuel elements as well as for imported fuels. Various other problems in the inspection of nuclear fuels have also been dealt with. The first effort has been made to obtain a criterion for the evaluation of welding practice for fuel rod end caps. Mechanical tests including tension and creep test, thermal cycle test as well as corrosion test were carried out on specimens of different designs which were so prepared as to have defects of known grade in the welded zone in order to determine the allowance limit of the types and grades of the defects there.

Standardization of fuel inspection techniques was the second problem: for example, in the measurement of density and grain size, method for thermal cycle test for uranium metal fuel core, measurement of particle size and O/U ratio of UO_2 powder, porosity and density of UO_2 pellets as well as in X-ray radiography of end cap welded zones.

Discussions were also made to find a suitable standard for the degree and range of application of various inspection methods for the respective research reactor fuels: specification of the fuel, operational conditions of the reactor and the experiences of manufacturing the similar type of fuels are among the important items considered. Eight research reactors already installed as well as other reactors yet on the planning stage were the subjects of consideration.